No 33.

THE Sidereal Messenger.

Conducted by Wm. W. PAYNE,
Director of Carleton College Observatory.

APRIL, 1885.

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"He telleth the number of the stars; He calleth them all by their names."

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"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

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*The Limits of Stability of Nebulous Planets, and the Consequences resulting from their Mutual Relations.** *By* PROF. DANIEL KIRKWOOD.

(*Read before the American Philosophical Society, Nov. 21, 1884.*)

To determine the height of the atmosphere is a problem of no common difficulty. This is evident from the fact that estimates derived from the phenomena of twilight, luminous meteors, and the aurora borealis have been widely various. It cannot extend, however, beyond the limit at which its elasticity is counterbalanced by the force of gravity—a limit probably not less than two hundred miles from the *Earth's* surface. Even the volume and weight of this atmospheric envelope are not absolutely constant, as small quantities of gaseous matter are doubtless brought into it from time to time by meteors and meteoric streams. Nor has this accession of matter from without been the only source of variation; it has been shown by several writers that the extent and density during the cycles of geologic time were in all probability much greater than at present.

But whatever the mass or density of the *Earth's* gaseous

*A preliminary discussion of equation (1) in the following paper was given in the *Analyst* for January, 1881. Those solutions are here revised, and the results for each planet carefully determined.

envelope, an absolute limit—corresponding to the *Earth's* present time of rotation—may be assigned it. "The atmosphere," says LAPLACE, "can only extend itself at the equator to the point where the centrifugal force exactly balances the force of gravity; for it is evident that beyond this limit the fluid would dissipate itself." This limit for the *Earth* is 26,240 miles from the center; for *Saturn* it is within the system of rings; and for the *Sun* it is at the distance of sixteen millions of miles. These distances, however, were obviously greater before the members of the system had contracted to their present dimensions. It is now proposed to find their original or maximum values.

In astronomy, as in other branches of physical science, many well-known facts remain still unexplained. This is true not only in regard to the fixed stars and the nebulæ, but within the narrower limits of the solar system. Recognizing the impossibility of accounting for present relations without considering the causes which operated in the distant past, astronomers have attempted to trace the process of formation from the primal chaos down to the origin of the youngest planet. In the theory of LAPLACE, the planets were formed from nebulous rings successively abandoned in the plane of the solar equator. The present writer, while not rejecting the nebular hypothesis itself, has indicated certain objections to the special form in which it was proposed by its celebrated author.* These difficulties, encountered in the theory of formation from *rings*, are avoided by supposing each planet at its origin to have been separated from a very limited arc of the equatorial protuberance. In either case, however, the dimensions of the primitive planet would be necessarily restricted by the law of gravitation.

It is sufficiently obvious that an original planetary mass in a nebular state could not have retained its continuity of form beyond a certain determinable limit; in other words, that it would have been changed into a ring by the attrac-

*Proceedings of the American Philosophical Society, Vol. XVIII, p. 324, and Vol. XIX, p. 15.

tion of the central body. The main design of the following paper, after finding in several cases the limits of equilibrium, is to trace, if possible, certain unexplained facts to their origin in these primitive relations between the various members of the solar system.

LIMITS OF PLANETARY EQUILIBRIUM.

If two nebulous bodies, M and m, revolve about a common center of gravity, the disturbing force of M on the superficial stratum of m is the difference between the attraction of the former on the nearest point of the surface of the latter and that on its center of gravity. The same is true, *mutatis mutandis*, in regard to the disturbing influence of m on M. If, then,

$a =$ the distance between the centers of M and m and

$x =$ the distance from the center of the former to the limit of the equilibrium of the latter, we shall have

$\frac{M}{a^2} =$ the attraction of M on the center of gravity of m,

$\frac{M}{x^2} =$ that on the nearest point of the surface, and

$\frac{M}{x^2} - \frac{M}{a^2} =$ the accelerating force of M on the portion of the surface of m between the two centers; but as these forces from M and m are in equilibrium, the neutral point, or the limit of m, may be found from the equation

$$\frac{M}{x^2} - \frac{M}{a^2} = \frac{m}{(a-x)^2} - \frac{m}{a^2} \quad (1).$$

Applying this equation to the solar system, x will be the equatorial radius of the solar nebula, and $a-x$ that of a planet at the epoch of its separation. Putting for simplicity $a=1$, aud reducing,

$$x^4 - 2x^3 + \frac{2M}{M-m}x = \frac{M}{M-m} \quad (2).$$

For *Jupiter*, $m=1$ and $M=1048$, hence

$$x^4-2x^3+2.0019102x=1.0009551. \quad (3).$$

therefore $x= 0.92501,$

$1-x= 0.07499,$

$(1-x)\times 480,000,000=35,995,200.$

Solving equation (2) in like manner for each of the principal planets we obtain the distance from the center of each to its limit as given in the following table:

Planet.	Dist. to Limit.
Mercury	152,000 miles.
Venus	700,208 "
Earth	1,082,147 "
Mars	764,650 "
Jupiter	35,995,200 "
Saturn	44,887,000 "
Uranus	48,915,000 "
Neptune	81,000,000 "

In these estimates we neglect the eccentricity of the orbits as well as the centrifugal force due to each planet's rotation. The masses and distances adopted are those given in NEWCOMB's Popular Astronomy, with the exception that for *Mercury* we have employed a mean between VON ASTEN's evaluation of the mass ($\frac{1}{7636440}$) and the final value given by LEVERRIER ($\frac{1}{5310000}$). The mean is $\frac{1}{6263800}$. For the *Earth* we have taken the sum of the masses of the *Earth* and the *Moon*.

Applying equation (2) to some of the secondary systems we find the following limits of stability:

For the *Moon*	39,850 miles.
Phobos	6.5 "
First satellite of *Jupiter*	5,250 "
Mimas	1,500(?) "

PRACTICAL APPLICATIONS.

The results obtained may now be employed in the approximate solution of several interesting problems. The limits of stability will be regarded as the primitive radii of the planets and satellites as any exterior matter would have been detached by the influence of the central body. To the primitive relations above developed may we not hope

to trace some of the unexplained facts of the solar system? As has been remarked by an eminent writer,* "the plan of the coming universe must have resided in the initial chaos, as certainly as the eagle is in the egg, or the leviathan in its primitive germ."

I. *To find the relative mean densities of the Earth and Moon at the epoch of their separation.*

With the notation used in equation (1) the ratio sought will evidently be

$$\frac{\rho M}{x^3} : \frac{m}{(a-x)^3}$$

where ρ = the ratio of the equatorial to the polar radius of the terrestrial spheroid. The value of this ratio is not known. An approximate value may be found, however, by a tentative process.

We have $a=240{,}300$ miles, $x=200{,}450$, $a-x=39{,}850$, $M=81$, and $m=1$. Hence the ratio is $0.636\rho : 1$.

But during the cooling period the ratio of the densities would probably be nearly constant; or, if the *Moon* contracted more rapidly, its solidification would occur earlier and the increase of its density practically cease. The present ratio of the mean densities is 5.67 : 3.57, and assuming this to have been constant we obtain

$$0.636\rho : 1 : : 5.67 : 3.57,$$

or,

$$\rho=2.498;$$

that is, the ratio of the *Earth's* equatorial to its polar radius at the epoch of the *Moon's* separation was nearly 5 : 2, and this may be regarded with some probability as nearly the ellipticity in other cases at the respective epochs of separation.

II. *To find the relative mean densities of Jupiter and his first satellite at the epoch of the latter's origin.*

Here $a=260{,}000$ miles, $x=254{,}750$, $a-x=5250$; and therefore the ratio is

$$\frac{59240\rho}{(254750)^3} : \frac{1}{(5250)^3} = 0.52\rho : 1,$$

and assuming the constancy of the ratio,

---

* Prof. PIERCE.

$$0.52\rho : 1 :: 121 : 100; \text{ or, } \rho=2.33.$$

This value of ρ is nearly equal to that found for the *Earth*; the difference being no greater than might result from the probable error in the elements used.

The present density of *Phobos* is unknown: but with $\rho=2.5$, the value found for the *Earth*, the ratio of the original densities of *Mars* and *Phobos* was 1.27 : 1. These results seem to indicate that the ratio of the equatorial to the polar radius of the central mass, at the epoch of a planet's or satellite's origin, was about 2.5.* With this value of ρ, and the value of x already obtained for each planet, the ratio of the mean density of the solar mass to that of the planets at the respective epochs of their separation would have been as follows:

For *Neptune*	1.31 : 1
" *Uranus*	1.31 : 1
" *Saturn*	1.39 : 1
" *Jupiter*	1.39 : 1
" *Mars*	1.25 : 1
" *Earth*	1.29 : 1
" *Venus*	1.27 : 1
" *Mercury*	1.22 : 1

From these numbers we infer that central condensation had commenced in the solar nebula before the origin of *Neptune*, and that the ratio of the mean density to the density of the equatorial parts near the surface was approximately the same at the successive epochs of planetary formation.

WERE THE PLANETS FORMED FROM NEBULOUS RINGS?

If the original solar mass, like most nebulæ, was irregular in form, the first matter detached would not probably be a ring, but a nebulous planet. As condensation advanced, the centrifugal force would increase until approximately equal to the central attraction. The disturbing influence of the planet already formed would produce, when in peri-

* It was shown by LAPLACE that a rotating homogenous fluid cannot retain its spheroidal form when ρ is greater than 2.7197. Mec. Cel. III, *iii*, § 20 [1605′], BOWDITCH's Trans. The ratio would be less in the case of central condensation.

helion, an increasing tidal-wave, resulting in the separation of a second planet. The origin of other planets is accounted for in like manner. If, in the ancient history of the system, nebulous matter, left at first exterior to the orbit of a new planet, should subsequently fall upon the central body, the effect would be not only a shortening of the period, but probably also a lessening of the orbit's eccentricity.

III. *The Peculiar Relations of the Martian System.*—Professor PICKERING estimates the diameter of *Phobos* at seven miles.* Adopting this value, and supposing the ratio between the densities of *Phobos* and *Mars* equal to that between the *Moon* and the *Earth*, we shall find the limit of the satellite's equilibrium to be 6.5 miles from its center, or three miles from its surface. Were the density reduced to that of *Saturn*, the limit would be almost exactly at the surface; or, with a density equal to that of *Mars* when the radius of the latter was that of the satellite's orbit, the limit would be at a considerable distance within the surface. Since, therefore, the satellite could never have existed at its present distance in a nebular state, it must follow, if any form of the nebular hypothesis is to be accepted, that its original distance was greater than the present. Can we assign a probable cause for this ancient disturbance?

Of the eight major planets, *Mars* has the most eccentric orbit, except that of *Mercury*; its perihelion distance being 13,000,000 miles less than its mean distance. This difference, in fact, amounts to 20,000,000 miles when the orbit of *Mars* has its greatest eccentricity. If, therefore, the radius of the *Sun*, or of the solar atmosphere, was somewhat greater than the least distance of *Mars* at the commencement of the latter's separate existence, the planet in perihelion would pass through the outermost equatorial zone of the solar nebula. This resisting medium would not only accelerate the motion of *Mars*, but also, in a much greater

* Annals of the observatory of Harvard college, vol. xi. Professor SETH C. CHANDLER makes the diameter still less. See Sci. Obs. for September, 1877.

degree, that of his extremely small satellites. The solar volume, meanwhile contracting more rapidly than the orbit of *Mars*, would finally leave the latter moving in an eccentric path, without sensible resistance.*

IV. *The Saturnian System.*—For *Mimas*, the first satellite of *Saturn*, the most probable values of the mass and density give the distance of the limit from the satellite's surface less than the radius of *Mimas*. The rings of *Saturn*, in all probability, could not exist as three satellites, the limits of equilibrium being interior to the surface. This is true at least in the case of the innermost ring. Analysis seems to indicate that PLANETS AND COMETS HAVE NOT BEEN FORMED FROM RINGS, BUT RINGS FROM PLANETS AND COMETS. If, without any loss of mass, the density of a planet were diminished until the radius should exceed the limit of equilibrium, what change would take place in the planetary form? Evidently a portion of the matter nearest the central body would be separated from the rest, and, as the orbital velocity would be less than that corresponding to its distance, it would move in a new ellipse, the aphelion of which would be the point of separation.

V. *Comets.*—The effect of the *Sun's* attraction in the dismemberment of comets is well known to astronomers. The nuclei of the large comets of 1680, 1843, 1880 and 1882 must have had great force of cohesion between their parts, in order to withstand the tendency to disintegration at the times of perihelion passage. Had the nuclei been either liquid or gaseous, or even clusters of solid meteorites, the

* This view was first presented in the *Observatory* for January, 1878. Different explanations of the short period of *Phobos* have been proposed by astronomers, but none, perhaps, entirely free from difficulties. One distinguished writer has suggested that $7^h\ 39^m$, the period of *Phobos*, was the rotation period of *Mars* at the epoch of the satellite's origin, and that the lengthening of the period to $24^h\ 37^m$, has been due to retardation by solar tides. But it is well known that the time of rotation of a planet in the process of condensation varies as the square of its radius. The resulting period of *Mars*, therefore, on reaching its present dimensions, would have been but a small fraction over one hour. This period, it is true, would have been somewhat modified by the counteracting influence of the solar tides; but the hypothesis referred to seems wholly inadequate to meet the objection derived from equation (2).

difference between the *Sun's* attraction on the central and the superficial parts would have pulled the comets asunder, spreading out the fragments into somewhat different orbits, like the meteoric streams of August and November.

This view of the gradual dispersion of comets in perihelion is in striking harmony with the facts of observation. The comets of short period have not only been divested of tails, which in all probability they originally possessed, but they seem to be losing more and more of the cloud-like matter which surrounds their nuclei. HALLEY's comet has lost much of its ancient splendor, and had its period been no greater than that of ENCKE's or BIELA's, it might long since have been reduced to a telescopic magnitude. The separation of BIELA's comet in 1845, was not the beginning of that body's dismemberment. We have evidence that this process had commenced before 1798, as in that year a meteoric shower, produced by its *debris,* was observed in Europe. A shower derived from the same group was again seen in 1838.* Before 1845, however, the separated fragments were too small to be individually recognized. How far the *Sun's* action alone can explain the facts, it may be impossible to determine.

VI. *The Zodiacal Light.*—Original small planets near the *Sun,* in a nebular or gaseous condition, would probably be transformed either into rings or meteoric clusters, the scattered particles of which, reflecting the *Sun's* rays, would present an appearance like that of the zodiacal light.

VII. *Origin of the Asteroids.*—In the primitive condition of a planet, immediately after its separation from the central mass, not only would the latter cause a considerable elongation of the former in the direction of the line joining their centres, but the planet's also—especially the larger—would produce great tidal elevations on the *Sun's* surface. Now, a comparison of the elements of *Hilda* and *Ismene,* the 153d and 190th asteroids, shows them to be an isolated pair whose periods are very nearly equal, each exceeding the longest in the interior cluster by more than

* HUMBOLDT'S Cosmos, BOHN'S ed., vol. iv., p. 582.

fifteen months. *Jupiter's* limit of equilibrium, when in the nebular form, was immediately beyond the orbits of these minor planets. If the *Sun* once extended to the aphelion distance of *Hilda* (4.632), the central attraction of his mass on a particle of the equatorial surface was but five times that of *Jupiter* at the point to which he was vertical.* The centrifugal force due to the *Sun's* rotation would be greatest at the crest of this tidal wave, produced by *Jupiter*, so that parts might become separated from the solar mass and transformed into asteroids. It is to be further remarked that two periods of *Jupiter* are approximately equal to three of *Hilda* and *Ismene*, that is, to three rotation periods of the *Sun* at the epoch of their separation. The disturbing effect of the "giant planet" on the tides of the central body would therefore be increased at each perihelion passage.† The process would be similar when one period of *Jupiter* was equal to two rotation periods of the central nebula.

VIII. *The Rotations of the Planets.*—It is well known that the analogy between the periods of rotation of the primary planets, as published by the present writer several years since, assigned a much longer period of rotation to *Uranus* than to *Jupiter* or *Saturn*. But as that of *Uranus* had not been measured, and the observations of the polar compression were by no means accordant, the fact was not then thought incompatible with the proposed law of rotation. Recent measurements, however, leave no room to doubt that the ellipticity is even greater than that of *Jupiter*, and consequently that the planet moves rapidly on its axis. The law connecting the rotation periods must accordingly require an important modification.

In a planet having a constant mass, with a variable volume, the time of rotation varies as the square of the radius. It is easy to show, however, that this law could not have obtained from the origin of the solar system. For instance, in tracing backward the history of the *Earth*, we find that

* *Jupiter's* perihelion distance is 4.95.

† The longitude of *Ismene's* perihelion differs from that of *Hilda's* by 180°.

when the radius was 8,000 miles, its rotation period, according to this law, was 96 hours; when the former was 12,000 miles, the latter was 216 hours; and, finally, if the *Earth* ever extended to the *Moon's* orbit, the time of rotation, by the same law, instead of having been equal to the *Moon's* orbital period, was nearly ten years. So likewise when *Mars* filled the orbit of *Phobos*, his rotation period was seven days and sixteen hours, or 24 times the orbital period of the satellite. We conclude, therefore, that during the earlier stages of its condensation all parts of the mass did not rotate in the same time. It is easy to see, in fact, that tidal retardation must have been much more effective at the surface than in the interior of a large planet in the gaseous state.

In so far as we know, the rotation periods of the smaller planets, *Mercury*, *Venus*, the *Earth* and *Mars*, are nearly two and a half times those of the larger and more remote. What cause can be assigned for this remarkable difference? In other words, why did the process of condensation continue longer in the large and less dense planets exterior to the asteroids than in the small bodies nearer the *Sun*? It may be answered in a general way that in small and dense planets solidification would occur at a comparatively early epoch in their history, and hence the acceleration of their rotary velocity would be, in a large measure, arrested. It seems probable, therefore, that, while the same law of rotation may obtain between the members of each separate group, it cannot apply where one of the planets is in the inner and the other in the outer cluster.

As regards their axial movements, the solar system appears to contain at least three distinct classes of planetary bodies; the obvious characteristics of each being traceable to their relative primitive densities. These are as follows, the primitive density of *Neptune* being taken as unity:

I. *The large planets:*

	Primitive Density.
Neptune	1.0000
Uranus	3.8950
Saturn	32.7073
Jupiter	210.7440

II. *The planets interior to the zone of asteroids:*

Mars	7,446.4
Earth	24,880.5
Venus	70,129.2
Mercury	468,616.0

III. *The secondary planets, of which our Moon and Jupiter's first satellite may be taken as types:*

Jupiter's first satellite	2,600,000
The *Moon*	4,820,000

There is, we may remark, an antecedent probability that the law truly formulated will assign to *Saturn* a period of rotation somewhat less than the period observed; as it is sufficiently obvious that if the ring had remained an integral part of the planet, the resulting time of rotation would have been, in fact, sensibly shorter than the present. It is also to be remembered that the late observations of DENNING and SCHIAPARELLI make *Mercury's* time of rotation nearly 25 hours. In the case of the satellites, the equality between the periods of rotation and revolution was established at an early epoch in their history. No further decrease in the time of rotation was therefore possible.

A comparison of quantities used in equation (1) suggests that a planet's time of rotation is a function of its mass, distance, and primitive density. The form of this function—found by a tentative process—may be expressed as follows:

The square of the number of a planet's days in its year is to that of any other of the same group, as the primitive density of the latter is to that of the former; that is,

$$n^2 : n'^2 :: \triangle' : \triangle \text{; or, } n' = n\left(\frac{\triangle}{\triangle'}\right)^{\frac{1}{2}} \quad (4),$$

where

$\triangle = \frac{m}{R^3}$ = the primitive density, and

$n = \frac{T}{t} = \frac{\text{orbital period}}{\text{rotation period}}$ = the number of a planet's days in its year.

Equation (4) may be reduced to

$$t^2 : t'^2 :: m\left(\frac{d}{R}\right)^3 : m'\left(\frac{d'}{R'}\right)^3 \quad (5),$$

where d, d' and R, R′ are the respective distances and primitive radii.

THE OUTER OR LESS DENSE GROUP.

In the following table the rotation periods of *Saturn*, *Uranus* and *Neptune* are derived from that of *Jupiter* by formula (4).

PLANET.	m	R	△	T	t	n
Neptune	16.86	81,000,000 m	1.0000	60,126.71 d	9h 35m	150,751.80
Uranus.....	14.46	48,915,000	3.8950	30,686.82	9 33	77,186.00
Saturn	93.84	44,887,000	32.7073	10,759.219	9 43	26,630.00
Jupiter.....	311.80	35,995,200	210.7440	4,332.584	9 55	10,492.64

It will be noticed that the theoretical period of *Saturn* is 31 minutes less than Hall's evaluation.

THE INNER GROUP.

PLANET.	m	R	△	T	t	n
Mars	0.1056	764,650m	7,446.40	586.98 d	24h 37m 23s	669.57
Earth......	1.0000	1,082,147	24,880.5	365.26	23 53 48	366.84
Venus	0.7690	700,208	70,129.2	224.70	24 42 54	218.18
Mercury....	0.0522	152,000	468,616.0	87.97	25 0 46	84.405

Here the rotation periods of the *Earth*, *Venus* and *Mercury* are derived from that of *Mars* by formula (4). The first is two minutes less than the true period; the time of *Venus's* rotation is doubtful; and the theoretical determination of *Mercury's* period agrees with the estimate of Mr. Denning.

The *Observatory* (March) records the transit of Wolf's comet over two small stars on the evening of Nov. 17, 1884. The first star was occulted at $13^h\ 44^m\ 58^s$ G. M. T.; the second about 50^m + later. Stars not identified.

Changes Observed on the Rings of Saturn by M. E. L. TROUVELOT, *Observatory Mendon, France. Translated from the French by* MISS MARY RIHELDAFFER, *Carleton College Northfield, Minn.*

In the year 1875 I showed* that the variable form of the shadow made by the globe of *Saturn* on the surface of the rings could not be the consequence of changes of level on the surface. I have shown that the nebulous ring had undergone great changes since the observations of BOND, LASSELL and others, and again, that the exterior border of CASSINI'S division was subjected to the changes of form which I have indicated.

My observations of this planet, continued with assiduity since this epoch, have only confirmed that which I published in 1875, and establishing definitely that the rings are not fixed, but very variable. As I am preparing now a plate of *Saturn* which ought to accompany a note more extended and detailed, I will confine myself to giving here a brief account of the important changes recently taking place in *Saturn*.

I will commence first with those occurring on the exterior ring A, and of which M. PERROTIN has lately interested the Academy. It is very plain that great changes are produced on this ring and on the ring B near it. ENCKE'S division does not exist, or if it does, it nearly coincides with CASSINI'S division. It is certain that I see nothing in its place with an eight-inch glass; but on the contrary I see a division larger and clearer than it was and much nearer the division Cassini.

On the 15th of February of this year (1884) I found for the first time that the division Encke had changed place. At the same time I found also that the Zone A, situated between this division and that of Cassini, was whiter and more luminous than I had apparently ever seen it. These changes must have been recent, for the 11th and 12th of

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*On some physical observations of the planet *Saturn*. Proceedings of American Academy of Arts and Sciences: Vol. III, p. 171.

February having observed *Saturn*, I took notice that this division of Encke was perfectly visible, and on the drawing that should accompany this note, is in its usual place.

On the evening of the 15th I also discovered these changes on the ring B. We know the ring is divided into three parallel zones. Since I have observed *Saturn* these zones have always appeared pretty nearly the same size. The internal zone, which is near the nebulous ring, is the deepest; and the external one, which forms the internal border of Cassini, is more brilliant. During this evening I found this last zone was narrower than the eastern limb and it size was diminished by less than one-half. It was also brighter, and could be distinguished from the grayish intermediate zone. I observed the same phenomenon the 20th of February, but this time on the western limb; whereas on the opposite limb it was difficult to recognize it.

In 1882 I observed the same changes very apparent on the internal zońe of the ring B which touched the nebulous ring and which was so deep it could hardly be distinguished. The nebulous ring showed the same remarkable changes. It was easily seen at the east and with difficulty distinguised at the west. The brilliant and narrow zone which is now on the ring A, between the division of Cassini and the new division of Encke was shown with variations of brightness on the limbs, so much that it was brilliant on the one and hardly seen on the other.

I have shown in the memoir cited above that the shadow of *Saturn* on the ring sometimes changes its form. The shadow did not have the same form to-day which I have seen in preceding years. The 15th of last February, the same day I observed the changes on the exterior ring A, and on the intermediate B, I found also that the shadow of the globe on the ring B, instead of, as formerly, one curve toward the planet, apparently formed two concave curves, united by their interior extremities, and forming a very marked angle, and at the intersection of these two curves this angle was a little nearer the division Cassini

than the nebulous ring. Since that day I have always seen the same form of double curves which were again visible to-day.

The beautiful ellipses described by the rings of *Saturn* around the planet appear to us of a symmetrical character, which is so evident that it imposes on us illusions difficult to break.

It is natural for observers to misrepresent these two limbs and to attribute the peculiarities in one to their mistakes. I, myself, often saw the changes of detail on one limb, but it was impossible to see the same of the opposite side, and supposed the symmetry was fixed, so attributed the irresistibility of these forms as a consequence of defect in the object-glass, or in my own eye, which made me see one side better than the other. To-day I found my error, and I am certain the surface is far from symmetrical. I also find the details of form are very rarely produced exactly the same on the other side. The rings are essentially variable.

These observations show us the rings are not solid masses, since changes are produced which could not be explained by the rotation of one piece.

The hypothesis that they are composed of a number of little satellites, describing independent orbits around the center of gravity of the planet, seems to us more probable, and in this case better explains the observed phenomena. It explains why it was impossible to determine the rotation of the rings.

By the experiences of photometry, well conducted but very delicate, made at opposition and quadrature of the planet, the conclusion is reached that the rings are really formed of little satellites. Indeed, if we know anything about these satellites, they ought to be more luminous toward the opposition, when they present their faces to us, which receive the direct rays of the *Sun*, than toward quadrature, when the face receives less light and is somewhat reduced by a commencement of the phase. It is certain toward the quadratures that the border next the *Sun* appears much darker than that turned toward us.

It ought to be the same with the satellites and this reduction of light would be sensible to our instruments.

THE NEW STAR OF 1572.

THE EDITOR.

There is nothing yet in the history of new or temporary stars that equals the record of the star of 1572. It was observed by TYCHO BRAHE, for the first time, on the evening of November 11th of the year above named, and its strange appearance to his practiced eye interested him so much, that he wrote a large book giving a detailed account of its changes, including also the views of his cotemporaries as to its probable origin.

Its place is in the constellation of *Cassiopeia* and quite near $0^h\ 19^m$; N. $63°\ 24'$ according to ARGELANDER. If the assumed one is really the TYCHO BRAHE star, it will be readily identified by means of a bright ninth magnitude star—8.9 according to ARGELANDER—which is No. 22 of his Zone 60. It follows this ninth magnitude $29^s.60$ and is south of it $10'\ 4''.1$ by micrometrical comparisons made at Twickenham observatory.

Those having small telescopes without circles, may find it north of the star *Kappa* of this constellation about one degree and a little west.

The chief things of interest about this star at the time of its discovery were its brilliancy, changes of color, time in view, and its disappearance.

It surpassed in luster the brightest of the fixed stars, was more brilliant than *Jupiter*, although then at his brightest, and even rivalled *Venus*. It was seen to shine through light clouds at night, and was noticed by some persons in daylight. It changed very little, if any, during the month of November, but not long after it began to fade gradually and continued so to do until March, 1574, when it ceased to be visible.

When first seen, its light was white like *Venus*, then yellowish in color, next ruddy like *Mars*, and finally of a leaden hue, appearing quite like the waning of the conflagration of a world, the hottest light first and the coolest last.

TYCHO BRAHE supposed the appearance to be caused by some ethereal substance like that of which the *Milky Way* was then thought to be composed, and that the waning might be accounted for by the action of the *Sun* and stars, or by spontaneous dissolving by some internal cause. As is doubtless well known to our readers, the more modern view is, that the origin of the phenomenon was some vast combustion on the surface of the star, which began in a sudden and tremendous outburst, and gradually sunk away through the succession of cooler colors that were plainly observed. As this took place forty years before the invention of the telescope, it will at once appear that the means of studying such a phenomenon scientifically were limited in the extreme at that time. It was not until the spectroscopic observations of a star of similar character in 1866 that anything definite was known as to the cause of these wonderful phenomena. Mr. HUGGINS, of London, was the first to offer the explanation. He saw the spectrum of the star of 1866 continuous and crossed by dark absorption lines, indicating that the star's light had passed through an atmosphere of comparatively cool gas. The meaning of this was, that a sudden and extraordinary outburst of hydrogen gas had taken place on the star, and by its intense heat and light had caused the changes well known in that and other stars. This explanation is fully in keeping with what can be seen, very frequently now, in common solar studies by the aid of the spectroscope, only on a smaller scale. The solar prominences are like these phenomena in character, apparently, and in 1883 there was much in the behavior of our *Sun* to make us think of conflagrations that might take place any time in stars younger in development than our central luminary.

The main thought in calling attention to the star of 1572 now, is not to offer an explanation of its phenomena, but, rather, to remind our readers who are observers, to give it some attention. If it be the same star that appeared nearly in the same place, in 945 and 1264, it may have a period of maximum of about 313 years, and that would bring the next

return at about the present time. Foreign observers have had these possibilities in mind, and have been giving attention to this star. The observatories of Pulkowa and Copenhagen have observed stars in this vicinity for the last ten or twelve years. In 1873, Mr. HIND and Mr. PLUMMER made frequent comparisons of the light of star 129 in D'ARREST'S catalogue and noticed fluctuations amounting to about one magnitude. If there should be another maximum of the brightness of this star like that of old, there is no danger that it would pass unnoticed, but it would be useful to science to observe the early states of change as well as the more marked ones.

EDWARD ISRAEL.

PROFESSOR M. W. HARRINGTON.

(*Extract.*)

After having completed his school-course at home with great distinction, he came to the University at Ann Arbor, in the autumn of 1877. He was one of the youngest of his class, but easily stood near or at its head. His predilections were decidedly for mathematical studies, and the writer of this sketch well remembers the difficulty which he seemed to have in understanding which was the hard and which the easy part of his tasks. He read with me WATSON'S Theoretical Astronomy, a work so advanced as to be beyond the range of most college students, and even to offer in places serious difficulties to the professional mathematician or astronomer. Mr. ISRAEL not only read the entire book in a half year, but he seemed entirely unconscious that he was doing anything extraordinary. I was particularly struck by the fact that he never knew that in his usual forty pages he had passed over something especially hard, unless I informed him of the fact. Our daily meetings, (for he made so much more progress than his one or two fellow members of the class that I met him alone,) soon changed from recitation to discussion of topics suggested by what he had read, and these discussions

would have been more animated had it not been for his modesty and reserve.

A few weeks before his graduation, there came the opportunity for me to nominate an astronomer for the expedition to Lady Franklin Bay. The nomination was offered to ISRAEL, with some hesitation. This was caused not by any doubt as to his ability to do the work, but by a partial knowledge of his domestic circumstances. He was idolized by a widowed mother to whom even the proposal to have him join a polar expedition would be painful. His circumstances in life were so easy that he could pursue, without anxiety as to income, any line of study which he might select. On consulting with him, the only motive which restrained him from accepting the nomination at once was a knowledge of the pain it would give his mother. With rare self-denial she encouraged him to do what he thought best, and he accepted the nomination, which was soon followed by his appointment. He left Ann Arbor in April of his senior year, and in consideration of his unusual merit, was given his degree in his absence.

As to his relations to the party and the work done by him, we make the following quotations from a letter from Lieut. GREELY to Mrs. ISRAEL, dated August 16, 1884: "It was owing to his careful astronomical observations, made under the most trying circumstances, that the time observations connected with the pendulum work, were successful. The pendulum observations, which, in the case of the English expedition of 1875–76, entirely failed, were in our case successfully made. These observations are said to be of the most valuable character, and your son will be credited therewith. In like manner I put him in charge of the magnetic work for which he will also receive credit."

"Your son, during the past terrible year, occupied the same sleeping-bag with me. He was a great comfort and consolation to me during the long weary winter and spring, until his death. To you, who know his gentle character and amiable disposition, it is hardly needful to state what impression he made on my affections. He was warmly

loved by all the men, and I readily believe he spoke the truth when he told me he was certain that he had not an enemy in the world."

Lieut. GREELY goes on to relate that at the time of his death, he did not forget those around him nor his friends at home. Having some money on his person, he requested that a small sum should be given to the family of each of the two Esquimaux of the party who had already perished. He also requested that a sufficient sum be reserved with which some survivor might visit his mother. The balance of the money, he desired, should be spent in purchasing delicacies for his surviving comrades while *en route* for home, and that the expenditures should be exceptionally lavish in the case of Corporal ELISON, who had lost both hands and both feet. Lieut. GREELY adds that he preferred to do this at his own expense, thus fulfilling an unique will, perhaps as remarkable and as admirable a one as the world ever saw for delicacy and thoughtfulness. To understand the character which dictated last wishes of such a nature, we must remember the circumstances under which he was placed, the desolation surrounding him, the natural ferment and souring of men's relations to each other when shut up together away from the rest of the world for year after year, the hardships of death from lack of nourishment and far away from kindred, when it was fairly certain that the survival of a few days would bring relief and life; under all these circumstances nothing but a character, a nobility of mind, and a philosophy which the world rarely sees, could have formed and expressed such last wishes.

ISRAEL died on May 27, only 26 days before the rescue. He met his death with great firmness and resignation, regretting it only on his mother's acount. His death was painless and easy, resulting from water around the heart, caused, of course, by insufficient nutrition. "His remarkable mental powers caused him to live 'till among the last," says Lieut. GREELY, "despite the fact that he was physically the weakest man of the party." His remains were received

at Kalamazoo with a great popular demonstration, and his funeral was attended by the common council and mayor of his native city in their official capacity.

We will make a single quotation from his letter from St. Johns to his mother, written June 29, 1881, immediately before he sailed for Greenland. He says: "I was greatly surprised to-day on examining our supplies; there is nothing which could possibly be carried of which we have not a great abundance. As far as safety and comfort are concerned, no expedition was ever as well equipped as ours."—*American Meteorological Journal.*

TYCHO BRAHE.

TYCHO, or TYGE, DE BRAHE, sometimes called the "Rectour of Astronomy," was born in 1546, at Knudstorp in Scania, which then belonged to Denmark. He was descended from an ancient princely family, the ruins of whose castle, Wisengsborg, are still to be seen on the shores of the Lake of Wetter. He was the second of ten children, and he, as well as his sister SOPHIA, gave promise of very great intellectual ability. After the death of his father, his maternal uncle, STENO BELLE, sent him to Copenhagen to study philosophy. He had early manifested a taste for astronomy, but his relatives designed him for the legal profession, and accordingly his uncle sent him in 1562 to pursue his studies at Leipsic. But the love of astronomy had become with BRAHE such a ruling passion that he would clandestinely leave the college buildings to make investigations. With only the aid of a small celestial globe and a wooden circle for the measurement of the stars, in 1563 he observed the conjunction of *Saturn* with *Jupiter*. The inheritance of not a small property in 1565, enabled him to follow his darling scheme of prosecuting astronomical experiments, in which he was encouraged by the Danish government. The king, FREDERICK II, recognizing his talents, requested him to give lectures in Copenhagen on mathematics and on comets. His reputation was, if possi-

ble, more firmly established by his discovery of a new star in the constellation *Cassiopeia*. The king at once took him under his especial patronage, giving to him a pension of 2,000 crowns and a canonry which yielded 1,000 crowns. He also gave to BRAHE the island of Huen, where in 1580 he had built for him a laboratory and magnificent observatory, which was called Uranienborg. A powerful impetus was there given to astronomical researches. He was visited by many celebrated personages.

BRAHE discovered two new inequalities of the *Moon*, besides other valuable observations, and was, perhaps, the first who had correct ideas about comets. His system, a modification of that of PTOLEMY, was not extensively adopted. But to BRAHE belongs the merit of having laid the foundation of practical astronomy. KEPLER afterwards used his numerous and wonderful observations in his own discoveries. Nearly twenty years his life was spent in assiduously following his astronomical pursuits. But, unfortunately, the king's death put a stop to all his hopes and aspirations. He became an object of persecution, owing to the hostility of WALCHENDORFF and other members of the regency and was driven from Uranienborg. In 1597 he was obliged to leave Denmark forever. The emperor, RUDOLPH II of Germany, invited the expatriated astronomer to a residence in his own chateau near Prague, assigning to him a pension of 3,000 florins. But BRAHE, who could not long survive being exiled from his beloved Uranienborg, died in 1601 and was interred in the Theinkirche. A beautiful marble effigy in Prague perpetuates his memory.

Little is known of his private life beyond the fact that when very young he incurred the displeasure of his relatives by a marriage with a peasant girl. The king tried in vain to effect a reconciliation. He was of a violent and hasty temper, excessively superstitious, always keeping near him a lunatic, whose ravings he regarded as prophetic.

"A Treatise on the New Phenomena of the Heavens" is one of the best of his astronomical works.—WACOOCHEE.

EDITORIAL NOTES.

There are but six copies of Vol. I of the MESSENGER yet remaining. These in plain binding are offered at $5.00 per volume. Volumes two and three, in same binding, can be furnished at $3.00 each.

The partial eclipse of the *Moon* March 29–30 was visible in the western Pacific Ocean, Asia and easterns portions of Europe and Africa. The magnitude of the eclipse, as computed, was 0.886, the *Moon's* diameter being 1.

The report for 1884 of government observatory at Hong Kong, by Dr. W. DOBERCK, the director, has just been received. The greater part of his time and energies since his arrival in Hong Kong, in July, 1883, has been spent in completing the observatory and in the arrangement of the instruments. The attention of the institution is given up mainly to meteorology and to this end it is supplied with a very complete set of self-registering apparatus of the most recent design, made under the supervision of the director, aided by the advice of Kew Committee.

A time-service is also contemplated and the establishment of a time-ball for the use of the shipping in the harbor of Hong Kong, but at the date of the report the horological apparatus had not been received.

In the department of astronomy, besides the instruments for the time-service, the observatory has the Lee equatorial, of 6-inch aperture, loaned to it by the Council of the Royal Astronomical Society. This has been mounted since the report was issued. J. T., JR.

THE UNIVERSAL DAY.

Executive Document No. 78 of the 2d Session 48th Congress deals with the official correspondence relating to the introduction of the Universal Day.

The first document of importance (No. 2) is a circular order of the Superintendent of the Naval Observatory dated Dec. 4, 1884, directing the use of the Universal Day on and after Jan. 1, 1885, in that institution, and

No. 3 informs Prof. NEWCOMB, Superintendent of the American Ephemeris, of this decision.

No. 4 is a long letter from Prof. NEWCOMB, dated Dec. 6, giving reasons why the Universal Day should *not* be adopted.

No. 5 (Dec. 11) is a letter from the superintendent of the observa-

tory in which he gives the reasons that seemed to him "sufficient to justify" the issuance of the order in question.

No. 7 is a circular letter to American astronomers from the superintendent of the observatory asking their views on the general subject and especially on the date at which the new system should be introduced. The replies were as follows:

No. 8. Prof. O. STONE; favors the change on Jan. 1, 1885.

No. 9. Prof. H. A. NEWTON; favors the change; suggests its immediate adoption, retaining the old system also to obviate confusion.

No. 10. Prof. E. C. PICKERING; regards an agreement among astronomers as of more importance than any special mode of reckoning.

No. 11. Prof. M. W. HARRINGTON; favors the change on Jan. 1, 1885.

No. 12. Prof. E. S. HOLDEN; does not favor the change and suggests Jan. 1, 1890 as the earliest date for its introduction.

No. 13. Prof. C. A. YOUNG; favors the change on Jan. 1, 1885.

No. 14. Prof. LEWIS SWIFT; favors the change on Jan 1, 1885.

No. 15. Prof. S. P. LANGLEY; favors the change on Jan. 1, 1885.

No. 16. Prof. C. H. F. PETERS; disapproves the change and suggests 1890 as the earliest date.

No. 17. Prof. J. G. PORTER; favors the change on Jan. 1, 1885.

No. 18. Prof. H. S. PRITCHETT; does not favor the change and suggests a delay of at least one year.

No. 19. Order of the superintendent suspending his former order introducing the Universal Day.

No. 19. Letter of the superintendent to Prof. NEWCOMB stating that of eleven letters received in answer to his circular only two decidedly oppose the change of day on Jan. 1, 1885, but that nevertheless his order is suspended.

No. 20. Circular of the superintendent to astronomers announcing that the "weight of opinion" is against the introduction of the Universal Day at present.

It is well understood that in any astronomical work involving figures, the greatest possible accuracy is needed to give the record value; but in records of experimental tests, or of phenomena merely, there is often an absence of specific detail which is needed to make such records most useful.

To illustrate: In England there is at present a discussion going on concerning certain reported comparisons between reflecting and refracting telescopes. Successive writers ask for important factors which were omitted from the recorded results.

There are also records published claiming the fifth star of the trapezium of *Orion* to be visible to observers with apertures as small as three inches, while one observer cannot see it with a 6-inch aperture. None, however, mention the power of the eye-piece employed, and

the "seeing" is supposedly perfect. Under this head comes the statement of the indefatigable observer Mr. BARNARD, on pages 313 and 314 of December number of the SIDEREAL MESSENGER that he could better see his comet with a 5-inch aperature than with a 6-inch. He gives the description of eye-piece used with the 5-inch, but leaves us to infer a much higher power used with the 6-inch, as he speaks of the "contracted field" (p. 313). If this inference is correct, then his conclusion that small apertures will show what larger ones fail in (sometimes) is not a fair one, as a higher power will blot from sight a faint object, readily seen with a low power. J. H. H.

The solar eclipse of March 16th was successfully observed here by Professor WILSON and myself. During the morning the sky was full of flying clouds and the *Sun* only shone at intervals through gaps. A few minutes before the computed time of first contact, the clouds broke away and allowed the *Sun's* limb to be watched uninterruptedly. Owing to the disturbed condition of the atmosphere the definition was very poor.

I observed with the 11-inch equatorial, aperature reduced to three inches and power 90. The probable uncertainty of the times noted would not exceed three seconds.

Professor WILSON observed with the 4-inch equatorial, projecting the *Sun's* image on a screen of white paper; diameter of the projection about five inches.

Local mean times of first contact.

PORTER,	23^h	09^m	$01^s.9$
WILSON,	23	09	04 .1
Computed from American ephemeris,	23	09	03 .0

At the last contact the sky was nearly free from clouds, but the *Sun's* limb was still very unsteady. A few seconds after the *Moon* had passed off, a small cloud obscured the *Sun.*

Local mean times of last contact.

PORTER,	2^h	00^m	$01^s.8$
WILSON,	2	00	00 .7
Computed from American ephemeris,	2	00	12 .0

J. G. PORTER,
Cincinnati observatory, March 17, 1885. Astronomer.

OBSERVATIONS OF SOLAR ECLIPSE AT ANN ARBOR, MARCH 15 AND 16, 1885.

The observations were made on the observatory grounds. In column I. are given the local mean times of observations made by myself in the large dome. In column II. those made by Mr. SCHAERBERLE in the small observatory 82 feet east and 80 feet south of the large dome; position, longitude $5^h\ 34^m\ 55^s.12$, latitude $42°\ 16'\ 17''.2$. The column marked III. contains the observation of Mr. LEVI WINES, teacher of astronomy in the High School, made in the High School observatory,

230 feet west and 66 feet north of the main dome; position, longitude $5^h\ 34^m\ 55^s.39$, latitude 42° 16′ 48″.7. The instruments were: for I., the 12-inch refractor stopped down to 6 inches, negative eye-piece magnifying 150 diameters; for II., the 6-inch refractor, with negative eye-piece magnifying 81 diameters; for III., 4-inch refractor.

The spots are numbered from the side of first contact. No I. is a spot near the edge; II. and III. are parts of an elongated group; IV a small pore following the preceding; and V. a spot with double umbra about as far from IV. as it is from III.

OBJECT OBSERVED.	HOUR AND MINUTE.		SECONDS. I.	SECONDS. II.	SECONDS. III.
	h	m	s	s	
First contact, ...	23	15	39	45.4	
Ingress of centre of spot I	23	34	0.5	17.5	
" " preceding end, umbra spot II.	23	55	28.5	34.0	
" " following " " " II.	23	56	20.5	9.0	
" " preceding " " " III.	23	57	1	15.7	
" " following " " " III.	23	58	54.5	48.7	
" " spot IV.	0	3	47.5		
" " preceding " " " V.	0	7	24	24.3	
" " following " " " V.	0	7		54.3	
Egress of preceding II. as above........	1	16		4.5	
" " following II. " "	1	16		39.4	
" " preceding III." "	1	17		45.0	
" " following III." "	1	19		54.0	
" " spot IV....	1	26		21.8	
" " " V. midway between spots.	1	30		23.2	
Last contact............................	2	7	2	0.3	1.0

The sky was nearly clear, but not entirely so.

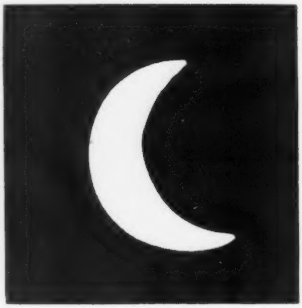
M. W. HARRINGTON.

From Red House observatory, Phelps, N. Y., Professor WILLIAM R. BROOKS writes that good observations were secured of the eclipse of the *Sun* March 16. Although the solar disc was at times partially hidden by light drifting clouds, the sky was fairly clear at the beginning of the eclipse. The definition was fair, although the limb of the *Sun* was unsteady. The first contact was accurately noted at 12h. 6m. 13s. standard time. Last contact lost by clouds.

At Carleton College observatory some attention was given to photographing the eclipse with improvised apparatus arranged by Prof. PEARSON of the department of Physics. The eye-piece of the 8¼-inch Clark equatorial was removed and an ordinary *camera* was attached. The full aperature of the objective was used and a spring slide, with narrow opening made the exposure on a slow plate, the time being about one-hundredth of a second. The cuts shcw the size

of the focal image of telescope, and will represent the pictures placed in the hand of the engraver. Of the six photographs secured, the four following were taken at the times respectively indicated, Central standard time being used:

Time: $11^h\ 42^m\ 15^s$ A. M.



Time: $11^h\ 46^m\ 30^s$ A. M.

The reader will easily see the relation of the *Sun* and *Moon* in the cuts, and follow the progress of the latter, if he be told that the views are in order, and that lines running through the middle of the cuts parallel to the length of the page would be nearly perpendicular to the Celestial Equator.

Time: $12^h\ 6^m\ 30^s$ P. M.

Time: $12^h\ 23^m\ 45^s$ P. M.

The third cut shows a phase about four minutes after greatest obscuration. The time of first contact was due at this place $10^h\ 35^m\ 38^s$. The *Sun's* limb was very unsteady, and observation was uncer-

tain by about four seconds. The contact was probably later by that amount.

As elsewhere more fully described, the appearance of the sky and the light at noon were in marked contrast with those of an hour before. The readings of the thermometer showed a fall of four degrees in the space of one and one-half hours.

Dr. T. D. SIMONTON of St. Paul observed the eclipse with a 3-inch telescope, with the following results as reported by the *Press:*

	Beginning.			End.		
	h.	m.	s.	h.	m.	s.
Predicted,	10	36	18	1	30	50
Observed,	13	35	20	1	30	57

The predictions were made by the careful and experienced computer, Mr. S. J. CORRIGAN of Nautical Office, Washington, D. C. For so good an observer as Dr. SIMONTON the errors are large, and throw some doubt on the accuracy of the predictions. Professor J. F. DOWNEY of the University used a telescope of $2\frac{3}{4}$ inches aperture and observations were said to agree with his previous calculations within a fraction of a second. This is interesting, considering the unavoidable errors of the ephemerides and the tentative methods of computation in common use for solar eclipses.

Winnipeg.—The sky was clear throughout the day. During the eclipse, the thermometer went down from $-11°$ to $-18°$, and during greatest obscuration, which occurred about noon, it was necessary to provide lights for convenience in observation. The first contact took place 11h. 8m. 3s; last contact, 12h. 59m. 4s. standard time. Fifteen-sixteenths of the solar disk was covered. Name of observer unknown. The correspondent of the *Tribune* graphically says:

The landscape presented a weird appearance and was quite dark at the greatest obscurity. The brute creation was bewildered—dogs barked during the whole time and cattle lowed; fowls sought their roosts and cocks crowed frequently. Some observers report seeing stars with the naked eye in the northern skies. Fifteen-sixteenths of the surface of the *Sun* was obscured at 12 o'clock. The Indians were in terror at its appearance.

Baltimore.—The eclipse was observed with small telescopes, but clouds prevented getting the times of first and last contact.

Washington.—It is reported that heavy clouds obscured the *Sun* the greater part of the afternoon. Some observations and a few photographs, however, were taken. Results of work have not been communicated.

Observations were unsuccessful, as reported, at Pittsburgh, much to the disappointment of Professor LANGLEY.

Observers at San Francisco were also unsuccessful on account of unfavorable sky.

At the Beloit College observatory the first contact was lost on account of clouds. The second contact was successfully observed by

Professor TATLOCK and Mr. R. C. CHAPIN; the former with the 9.5-inch equatorial and the latter with the 3-inch finder of the same. Some occultations of solar spots were also observed.

Letters from Cordoba, South America, written February 7th, state that Dr. GOULD is pushing his work so as to leave as soon as possible. He has sent in his formal resignation and Dr. THOME has been appointed director in his place. Mr. R. H. TUCKER, formerly assistant at the Dudley observatory, who went to Cordoba, in the Spring of 1884, has been promoted to be second assistant. J. T., JR.

Special Circular No. 56, *Science Observer* reports the following discoveries:

A cable message from Dr. KRUEGER, received March 7, announces the discovery of an asteroid by BORELLI.

March 6, 8^h 45^m 36^s. Greenwich M. T.

R. A. 11^h 6^m $13^s.5$. Decl. $+ 7° 9' 17''$

Daily motion in R. A. $- 48^s$; in Decl. $+ 9'$.

Eleventh magnitude.

A cable message from Dr. KRUEGER, received March 10, announces the probable discovery of POGSON's lost planet, by Dr. PALISA.

March 9, 8h. 28m. 45s. Greenwich M. T.

R. A. 6h. 44m. 41.7s. Decl. $+ 28° 10' 1''$.

Possible discovery of Comet 1867 (II).—A cable message from Dr. COPELAND, at Dun Echt, received March 14, announces the observation of a suspicious object by Dr. GAUTIER of Geneva, which may be a return of Comet 1867 II. (Tempel.)

A telegram from Professor PICKERING, of Harvard College observatory, received March 18, states that the suspected comet is a nebula.

Professor C. W. PRITCHETT, Morrison Observatory, Glasgow, Mo. at opposition of *Mars* in 1879-80 made micrometer measures of his diameter. This work was repeated at the planet's opposition in 1881-82.

The general mean of his results as given in A. N. No. (2652) is for

$$1879\text{-}80 = 9''.486 \pm 0.033$$
$$1881\text{-}82 = 9\ .484 \pm 0.036$$

A recent number of the Chico *Chronicle* (California) contains an account of the fall of an ærolite. It was attended by a brilliant train of light and fell but a short distance from Chico, Butte Co., Cal. Its length was over thirty feet; diameter, two and its shape pyramidal. The burning rock struck on a lava formation and glanced off plowing a gutter nearly two feet deep for a distance of two hundred feet. Its weight is estimated at several tons.

We gladly give place to the following important communication, not only because of the courtesies frequently extended to the MESSENGER by the Royal Astronomical Society, but also because of the interest that such information may be to American astronomers. We have in our possession a full description of the instrument referred to, which will be cheerfully communicated to any desiring more particular information.

For Sale.—A Heliometer of four inches aperture, by the REPSOLDS of Hamburg, the property of DAVID GILL, H. M. Astronomer at the Cape. The instrument is in perfect working order. Owner parts with it because his work is to be continued with a larger instrument. Particulars may be had on application to the Assistant Secretary, Royal Astronomical Society, London.

QUERIES.

1. Do observers this year notice any difficulty in the study of the details of the planets not seen in previous years?

2. Observing the Moon with a 3½-inch telescope, a small crater inside of *Hercules* is seen to give a dull red light instead of being filled with a black shadow. Why is this?

Knowledge (English), in late numbers, is giving fresh and enjoyable articles on astronomical subjects. In the last before us (No. 176) is found a continued article on "Life in other Worlds," by Mr. PROCTOR. Another by J. R. GREGORY on "Meteoric Stones."

At the February meeting of the Royal Astronomical Society Dr. WILLIAM HUGGINS was awarded the gold medal of the Society for his researches on the motions of stars in line of sight, and on photographic spectra of stars and comets.

Science No. 111 contains a brief article on *Researches in Stellar Parallax*, by Professor DAVID TODD in which reference is made to the principal stars that have been studied recently, in this particular. Dr. BALL, royal astronomer of Ireland, is deservedly complimented for his successful labors in this branch of astronomy.

Mr. C. E. CRANE, of Waseca, Minn., is highly pleased with the work of his 6½-inch Brashear reflector.

Subscribers will please notice that the MESSENGER is numbered consecutively on the first cover page. On the title page the number and volume are also given. The index accompanies the last number of each volume, and will be easily found by this arrangement.

During the year 1884 nine minor planets were discovered. Of these six were found by M. PALISA of Vienna.

The following subscriptions and orders have been received since last acknowledgement:

L'Observatoire de Paris, Paris, France; F. J. Stettler, Slatington, Penna.; J. J. Gilbert, Olympia, W. T.; Prof. Dascom Green, Troy, N. Y.; Cincinnati observatory, Mt. Lookout, Ohio; Prof. W. C. Gurley, Marrietta, Ohio; Fletcher Denell, Carlisle, Pa.; Rector S. S. Chevers, Shamokin, Pa.; J. B. Cummings, New Wilmington, Pa.; E. Crocker, Berea, Ohio; W. Glover, Boston, Mass.; J. Howard Watters, Cooptown, Md.; Prof. Coleman Bancroft, Hiram, Ohio; Prof. R. C. Crompton, Jacksonville, Ill.; William Evans, Philadelphia, Pa.; American News Co., New York City (Vols. I, II and III, bound). Wm. H. Dolbeer, Taylorsville, Ind.

BOOK NOTICE.

Curve Tracing in Cartesian Co-ordinates. By W. W. JOHNSON, Professor of Mathematics in the United States Naval Academy. New York: JOHN WILEY & SONS, 15 Astor Place, 1884; pp. 86.

The object of this little book is the study of the definite problem ascertaining the form of a curve, given by its equation in Cartesian co-ordinates, in such cases as are likely to arise in the applications of analytical geometry. As the book does not discuss the general theory of curves, the calculus is not employed, but algebraic processes only are used. The new and interesting feature is the introduction of the analytical triangle at an early stage as an instrument frequently employed in methods of approximation, as derived from NEWTON's parallelogram and CRAMERS method of representing possible terms by points.

For so small a book the range is considerable, exercises abundant, and its progressive character satisfactory. The publisher's part is neatly done.

L'Astronomie, Revue mensuelle d'Astronomie populaire, de Meteorologie et de Physique du globe, par M. CAMILLE FLAMMARION. No. de Mars 1885. "Les tremblements de terre," par M. C. FLAMMARION. "Nouvelles observations sur Jupiter," par N. W.-F. DENNING, astronomie a Bristol. "Mouvement propre d'une etoile de 11 e grandeur." Etude oceanographique," par le colonel H. MATHIESEN. "Nouvelles de la Science." "Varietes:" Six trombes marines observees dans l'espace d'une demiheure. Halo et parhelie observes a Orleans. "Observations astronomiques," par M. E. VIMONT. Ce No. continent 19 figures. (GAUTHIER-VILLARS, quai des Augustins, 55, Paris.)